


**VIRGINIA DEPARTMENT OF TRANSPORTATION**

***TRAFFIC ENGINEERING DIVISION***

**MEMORANDUM**

<b>GENERAL SUBJECT:</b>  BARRIER SYSTEMS		<b>NUMBER:</b> TE-367.0
		<b>TO SUPERSEDE:</b> N/A
<b>SPECIFIC SUBJECT:</b>  <b>GUARDRAIL SYSTEM SPOT REPAIR</b>  Damage Condition Ratings and Repair Strategies for Damaged Guardrail Systems		<b>DATE:</b> March 8, 2013
		<b>SUNSET DATE:</b> None
<b>DIRECTED TO:</b>  District Administrators Regional Operations Directors District Maintenance Managers District Construction Engineers State Maintenance Engineer State Location and Design Engineer State Structure and Bridge Engineer Regional Operation Maintenance Managers Regional Traffic Engineers Residency Administrators	<b>SIGNATURE: State Traffic Engineer</b>  	

Guardrail systems are roadside safety features for redirecting errant vehicles from a dangerous path. When guardrail systems are damaged, they may not be able to fully perform their intended functions and may become hazards themselves. The repair, replacement, and/or upgrade of damaged guardrail systems are critical to the safety of the traveling public and therefore should be conducted as soon as is practical.

The enclosed "Virginia Department of Transportation Guardrail Spot Repair Guidance" provides guidance for determining damage condition ratings and repair strategies for damaged guardrail systems. This memo shall be used in conjunction with TE Memo-366, which provides guidance on determining the functional condition ratings and strategies to systematically upgrade existing guardrail systems and end treatments. A functional condition assessment of the entire damaged guardrail run is recommended prior to assessing the damage condition rating in order to determine whether the entire guardrail run should be replaced in lieu of planning spot repairs.

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**Enclosure:** Virginia Department of Transportation Guardrail Spot Repair Guidance

# **Virginia Department of Transportation Guardrail System Spot Repair Guidance**

Central Office  
Traffic Engineering Division  
March 8, 2013

## 1. POLICY BACKGROUND

Guardrail systems are roadside safety features for redirecting errant vehicles from a dangerous path. The term “guardrail system” here refers to typical guardrail sections such as W-beam and cable barriers, transition areas, and end treatments. When guardrail systems are damaged, they may not be able to fully perform their intended functions to protect errant vehicles and sometime may become hazards themselves. The repair, replacement or upgrade of damaged guardrail systems is critical to the safety of the traveling public and therefore should be conducted as soon as practical.

This memo provides guidance for use in determining the **damage condition ratings** and repair strategies for damaged guardrail systems. The process is outlined in the **Guardrail Repair Decision Tree in Appendix A**.

### Related Policy Guidance

This memo shall be used in conjunction with TE Memo-366, which provides guidance on determining the functional condition ratings and strategies to upgrade existing guardrail systems. A functional condition assessment of the entire damaged guardrail run is recommended prior to assessing the damage condition rating in order to determine whether the entire guardrail run should be replaced in lieu of planning spot repairs.

A methodology outlining the process for periodically collecting physical inventory information and functional condition information will be established under a separate memorandum.

Refer to the latest **IIM-LD-220** for guidance and guidelines on upgrading existing guardrail systems associated with construction and major rehabilitation projects. Refer to the **VDOT Guardrail Installation Training (GRIT) Manual** for general information on the installation, replacement and repair of guardrail systems. All new guardrail installations shall comply with current VDOT standards and specifications.

## 2. EVALUATING DAMAGE CONDITION OF GUARDRAIL SYSTEMS

The severity of the damaged portion of the guardrail systems is measured using damage condition ratings. A functional condition assessment of the entire damaged guardrail run is recommended prior to assessing the damage condition rating in order to determine whether the entire guardrail run should be replaced in lieu of planning spot repairs.

Refer to the Guardrail Repair Decision Tree in Appendix A for the process and TE Memo-366.

## 2.1 Damage Condition Ratings

### General Criteria

The following provides general criteria to determine the damage condition ratings of guardrail systems. The general criteria should only be used for scenarios which are not address in the detailed criteria in Appendix B.

**No Damage** – No visible damage to the guardrail system.

**Minor** – Damage to the guardrail system is minor. Although the guardrail system may not be aesthetically pleasing, it will perform its intended function.

**Moderate** – Damage to the guardrail system is obvious but the guardrail system still maintains its structural integrity and will work for most traffic conditions.

**Severe** – Damage to the guardrail system is so severe that the guardrail system no longer functions as designed or has become a hazard itself to the traveling public.

### Detailed Criteria for Major Types of Guardrail Systems

Detailed criteria to determine the damage condition ratings of each guardrail element for systems such as W-beam guardrail and end treatments are listed in **Appendix B**. A brief damage condition summary for the major guardrail types is as follows:

#### W-Beam Guardrail Systems

**No Damage:** No visible damage to the guardrail system.

**Minor:** Less than 6 inches of post or rail deflection, no missing posts and damaged limited to less than 60% of the guardrail run.

**Moderate:** 6 to 9 inches of post or rail deflection, no missing posts and damaged limited to less than 60% of the guardrail run.

**Severe:** Greater than 9 inches of post or rail deflection, missing or broken posts, or 60% or more of the guardrail run is damaged.

Note: Weathering Steel (COR-TEN or ASTM A588) Guardrail Systems are no longer acceptable for use in most situations due to the potential for premature material failure from excessive rust. Except in rare situations, as discussed in Section 4 of TE-366, any damage to the weathering steel guardrail system shall be rated no better than moderate.

#### Cable Systems

**Severe:** Any damage to cable guardrail or terminal end treatments.

### 3. GUIDANCE ON GUARDRAIL REPAIR STRATEGIES AND TIMELINES

To determine the repair strategies and timelines for damaged guardrail systems, the process outlined in the Guardrail Repair Decision Tree (Appendix A) should be followed. Factors such as the functional condition rating of the entire run of the guardrail systems, damage condition ratings, road functional classification, etc. should be considered. The following section provides detailed guidance on the repair strategies and timelines for damaged guardrail systems.

#### 3.1 Repair Strategies

##### **General Strategies**

Damaged guardrail systems should be repaired, replaced, or upgraded to the latest FHWA/VDOT standards whenever possible. Repair must be prioritized based on the damage severity and remaining functionality of the damaged guardrail systems. All other factors being equal, repairing and upgrading damaged sections of guardrail should be given priority over upgrading substandard but undamaged guardrail.

When determining the proper repair strategies of damaged guardrail systems, the functional condition rating of the entire run should be accounted for and used to determine the most cost effective option. **If the guardrail standard section and end treatments have different functional conditional ratings, the standard section's functional condition rating shall be used as the rating of the entire run of guardrail system when using Appendix A.**

For damaged guardrail systems with **a functional rating of Grade C or D**, the option of upgrading the entire run of guardrail in lieu of repairing only the damaged portion shall be considered.

Where 60% or more of the length of the entire guardrail run is damaged, the entire run of the guardrail system should be upgraded. Refer to the decision tree chart in Appendix A.

When an entire run of guardrail needs to be upgraded, all barrier and terminal systems shall be replaced with systems meeting the appropriate National Highway Cooperative Research Program (NCHRP) criteria.

Upon the discovery of a guardrail system with **severe** damage, repairs shall be made as soon as possible. Until such times that the repairs are made, temporary warning devices should be placed to warn motorists of the damage.

##### **Specific Strategies**

The specific strategies to repair or upgrade major guardrail types are shown below. Users should use engineering judgment to determine the best strategy for each specific case.

- **Standard GR-1**

For damaged segments of Standard GR-1, the entire run should be upgraded with the current Standard GR-2 guardrail.

- **Standard GR-2**

For damaged segments of Standard GR-2, where the entire run is 200 feet or less and has a functional condition rating of Grade D, the entire run should be upgraded to current Standard GR-2. If the run has a functional condition rating of Grade C or above and the damage is less than 60% of the entire run, the damaged portion may be replaced with current Standard GR-2 guardrail in lieu of upgrading the entire run. The remaining undamaged segment should be scheduled for upgrading to current Standard GR-2 per upgrade timeline guidance in TE-366.

For damaged segments of Standard GR-2, where the entire run is longer than 200 feet and the damage is less than 60% of the entire run, the damaged portion may be replaced with the current Standard GR-2 guardrail in lieu of upgrading the entire run. The remaining undamaged segment should be scheduled for upgrading to current Standard GR-2 per upgrade timeline guidance in TE-366.

In cases where 60% or more of the length of the entire run is damaged, the entire run should be replaced with current Standard GR-2 guardrail.

- **Standard GR-3**

An existing Cable Guardrail System that is damaged shall be replaced with a Cable Guardrail System meeting current GR-3 guardrail system standard, or, if the site conditions are appropriate, a GR-2 or GR-8 system meeting current standards.

- **Standard GR-4, GR-FOA, and Bridge-Guardrail (BR-GR) Attachments**

Damaged GR-4, GR-FOA, and BR-GR attachments shall be replaced with a Standard GR-FOA or current BR-GR design, as appropriate.

- **Standard GR-5**

Damaged GR-5 terminals on non-NHS roadways shall be replaced with an appropriate terminal treatment meeting NCHRP 350 criteria.

- **Standard GR-6**

Damaged GR-6 terminals shall be replaced with the current Standard GR-6 terminal, provided the existing installation meets the current site requirements for a GR-6 terminal.

- **Standard GR-7**

A site investigation shall be made to determine whether the damaged GR-7 terminal should be repaired, replaced, or eliminated.

If the space between two runs of guardrail is  $\leq 200'$ , closing the gap by continuing the run of guardrail is recommended, thereby eliminating the need for a terminal. If a cut slope is within approximately 200' longitudinal distance from the location of the terminal meeting site requirements to install a Standard GR-6 terminal, the guardrail should be extended to the cut slope and a Standard GR-6 terminal should be installed.

If the installation site does not provide at least 75' of clear run-out path in addition to the length of need required for the barrier (exclusive of the terminal), a Standard GR-9 shall be installed. If an extensive amount of grading would be required for site preparation in order to install a Standard GR-7 terminal, consideration should be given to installing a Standard GR-9 terminal.

- **Standard GR-8**

For damaged GR-8 guardrail, where the entire run is 200 feet or less and has a functional condition rating of Grade D, the entire run should be upgraded with the current Standard GR-8 guardrail meeting NCHRP 350 Test Level 3 criteria or, if the site conditions are appropriate, a GR-2 or GR-3 system meeting current standards. If the run has a functional condition rating Grade C or above and less than 60% of the entire run is damaged, the damaged portion may be replaced with current Standard GR-8 guardrail in lieu of upgrading the entire run. The remaining undamaged segment should be scheduled for upgrading to current standards per upgrade timeline guidance in TE-366.

For damaged GR-8 guardrail, where the entire run is longer than 200 feet and less than 60% of the entire run is damaged, the damaged section may be replaced with GR-8 guardrail meeting current standards and the current GR-INS transition standard in lieu of upgrading the entire run. If the site conditions are appropriate, a current Standard GR-2 system, including a proper transition per Standard GR-INS, may replace the GR-8. The remaining undamaged segment of the same run should be scheduled for upgrading to the current Standard GR-8 or GR-2 guardrail per the upgrade guidance in TE-366.

In cases where 60% or more of the length of the entire run is damaged, the entire run should be considered for replacement with current Standard

GR-8 or GR-2 guardrail.

- **Standard GR-9**

A site investigation shall be made to determine whether the damaged GR-9 terminal should be repaired, replaced, or eliminated. If the space between two runs of guardrail is  $\leq 200'$ , closing the gap by continuing the run of guardrail is recommended, thereby eliminating the need for a terminal. If a cut slope meeting site requirements to install a Standard GR-6 terminal is within approximately 200' of the location of the terminal, the guardrail should be extended to the cut slope and a Standard GR-6 terminal should be installed.

- **Standard GR-10**

For a damaged Standard GR-10, the guardrail shall be replaced with a GR-10 meeting the current Standards.

### **3.2 Repair Timelines**

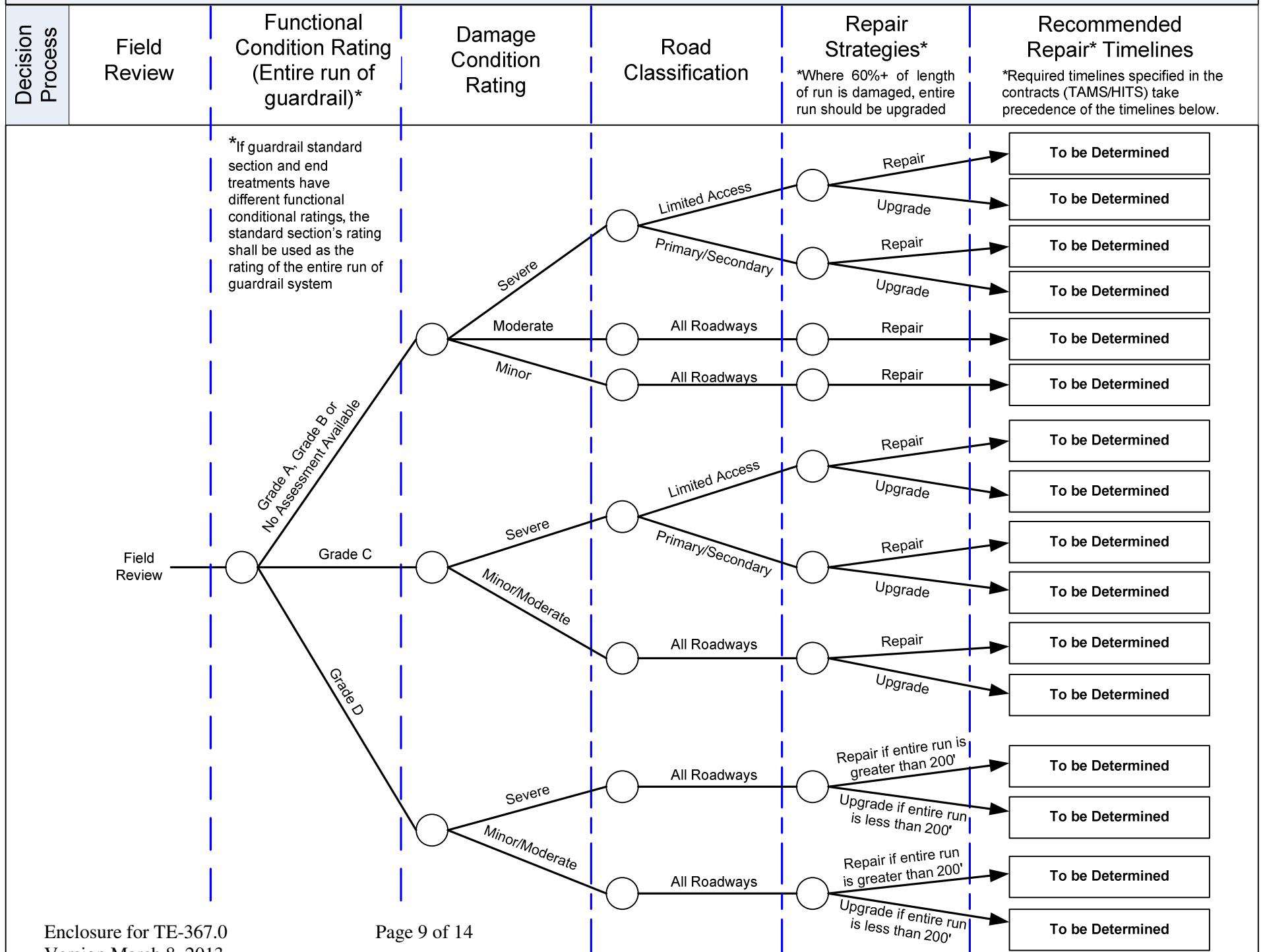
Unless otherwise noted, the general recommended timelines to repair damaged guardrail systems are as follows:

- **Minor** – Immediate repair is not required. Repair or upgrade should be scheduled as funding becomes available.
- **Moderate** – Damaged section should be scheduled for repair or upgrade within a reasonable time.
- **Severe** – Damaged section should be scheduled for repair or upgrade as soon as possible. Warning devices should be installed immediately and remain in place until the repair or upgrade is made.

Traffic Engineering Division will work with region and district stakeholders to determine feasible timelines guidance for guardrail system repair for each roadway classification. This memo will be updated when concurrence on the repair timelines is reached.

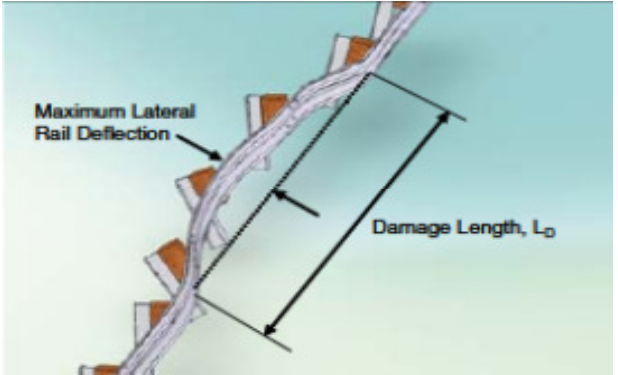
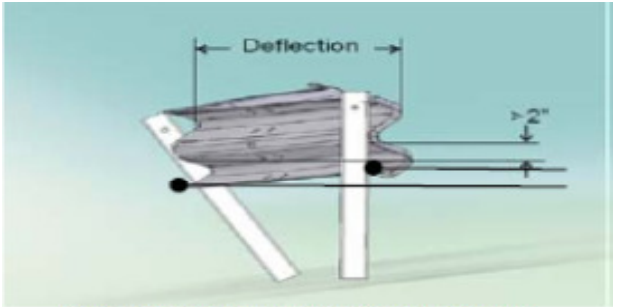
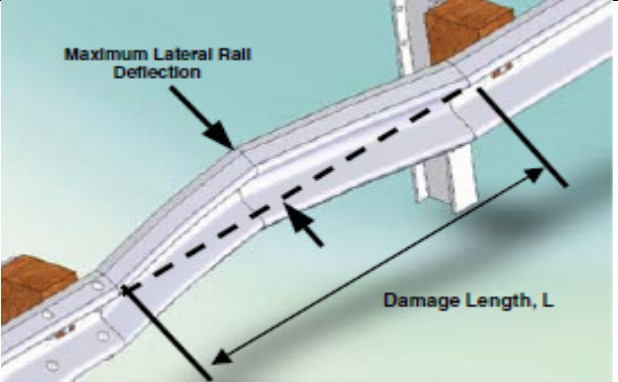
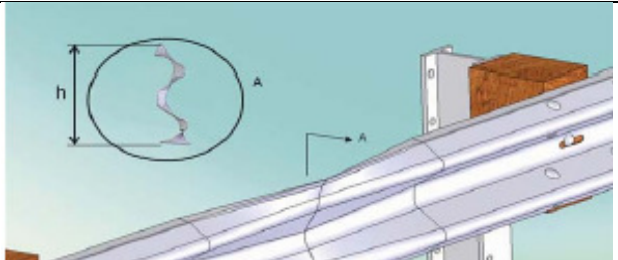


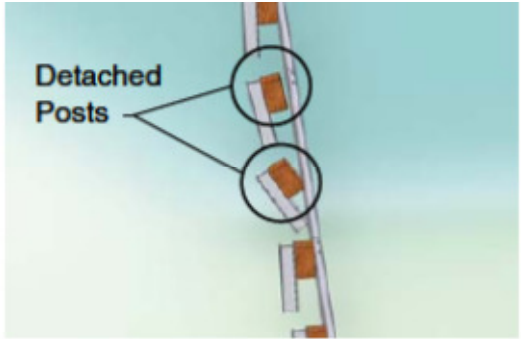
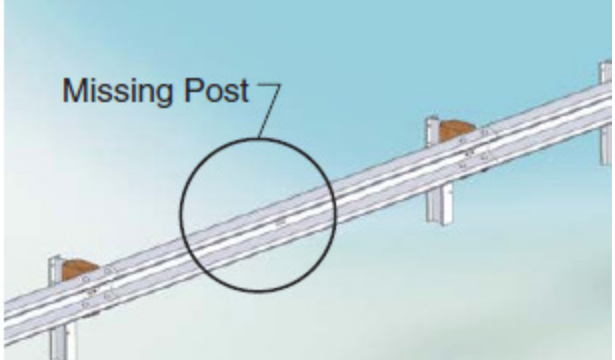
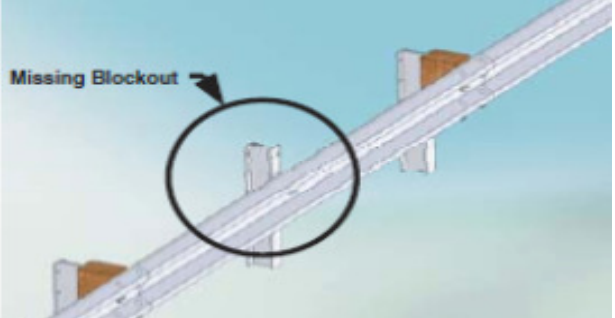
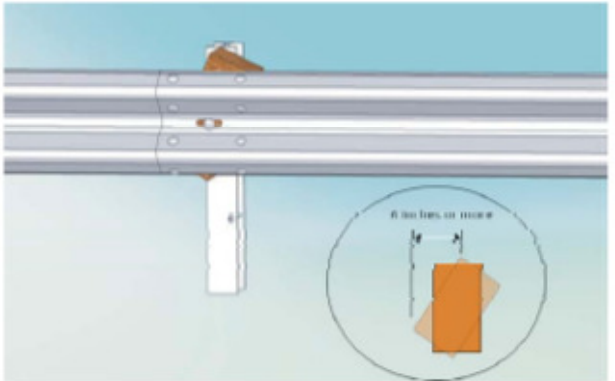
# Appendix A: VDOT Guardrail Repair Decision Tree

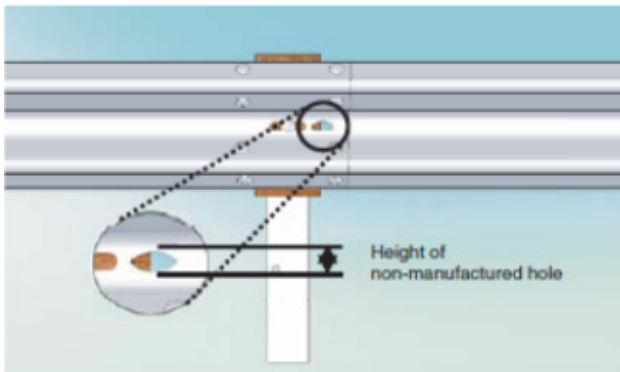
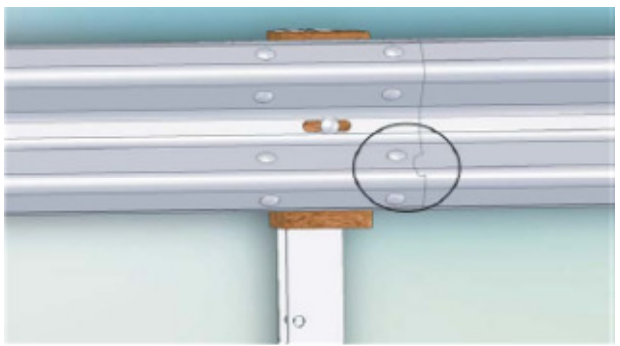
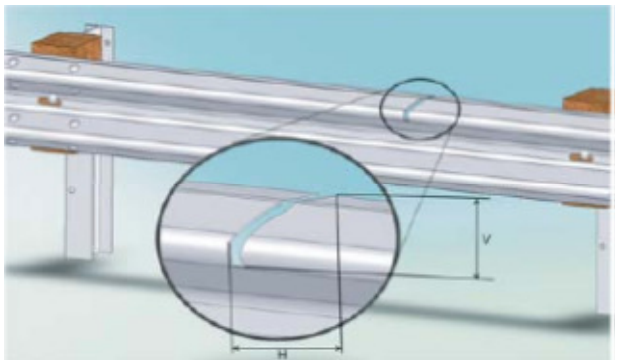
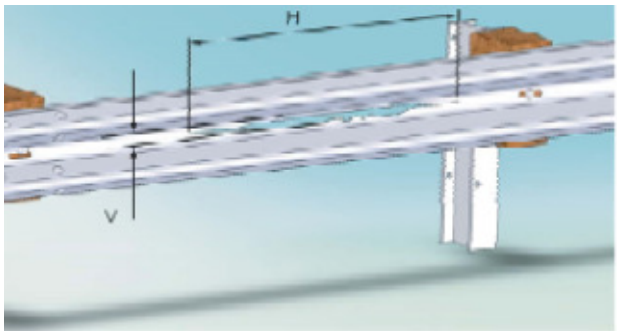


## Appendix B:

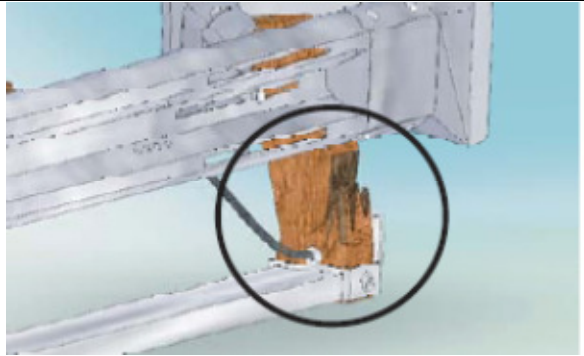
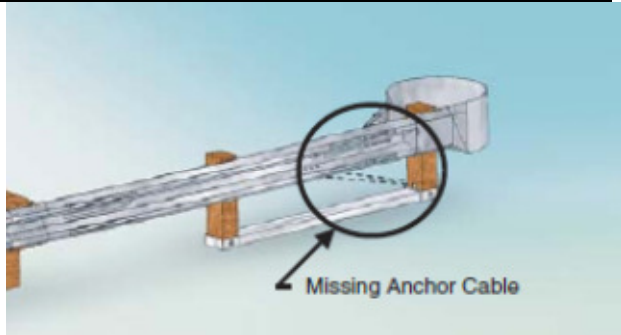
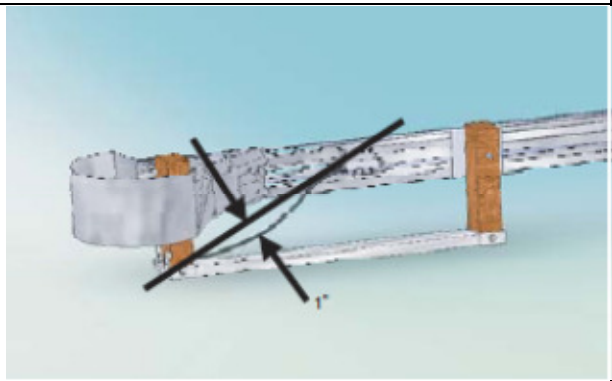
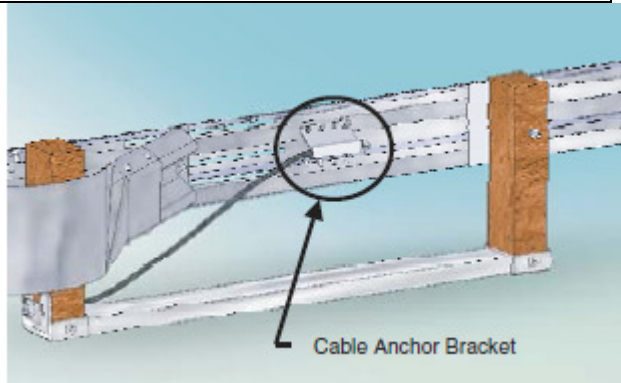
**Table B-1 W-beam Barrier Damage Condition Rating Criteria (Detailed)**

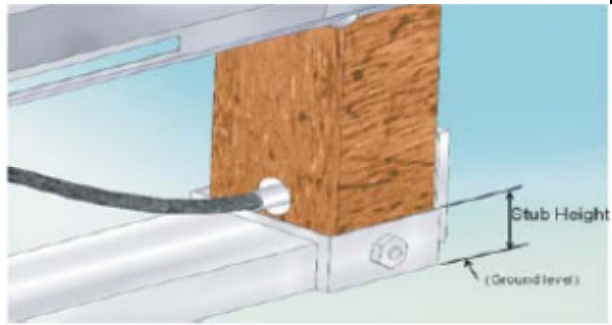
Damage Mode	Extent of Damage (One or more of the following thresholds)	Damage Condition Rating (No better than)	Measurement
Post and Rail Deflection	More than 9 in. of lateral deflection anywhere over a 25-ft length of rail  Top of rail height 2 or more inches lower than original top of rail height	Severe	  <p>(Weak Post W-Beam Shown Only for Clarity. Each measurement taken at the rail's middle fold)</p>
	6-9 in. lateral deflection anywhere over a 25-ft length of rail	Moderate	
	Less than 6 in. of lateral deflection over a 25-ft length of rail	Minor	
Rail Deflection Only	6-9 in. of lateral deflection between any two adjacent posts  <b>Note:</b> For deflection over 9 in., use post/rail deflection guidelines.	Moderate	
	Less than 6 in. of lateral deflection between any two adjacent posts	Minor	
Rail Flattening	Rail cross-section height is more than 17 in. (such as may occur if the rail is flattened)  Rail cross-section height is less than 9 in. (such as dent to the top edge)	Moderate	

	Rail cross-section height is between 9 and 17 in.	Minor	
Posts Separated from Rail	2 or more posts with blackout attached with a post/rail separation less than 3 in.  1 or more posts with a post/rail separation which exceeds 3 in.	Moderate	 <p><b>Detached Posts</b></p> <p><u>Note:</u></p> <ol style="list-style-type: none"> <li>1. If the blackout is not firmly attached to the post, use the missing blackout guidelines.</li> <li>2. Damage should also be evaluated against post/rail deflection guidelines.</li> </ol>
	1 post with blackout attached with post/rail separation less than 3 in.	Minor	
Missing/ Broken Posts	1 or more posts: <ul style="list-style-type: none"> <li>• Missing</li> <li>• Cracked across the grain</li> <li>• Broken</li> <li>• Rotted</li> <li>• With metal tears</li> </ul>	Severe	 <p><b>Missing Post</b></p>
Missing Blockout	Any blockouts: <ul style="list-style-type: none"> <li>• Missing</li> <li>• Cracked across the grain</li> <li>• Cracked from top or bottom of blackout through post bolt hole</li> <li>• Rotted</li> </ul>	Moderate	 <p><b>Missing Blockout</b></p>
Twisted Blockouts	Any misaligned blockouts, and the top edge of the block is 6 in. or more from the bottom edge  <u>Note:</u> Repairs of twisted blackout are relatively quick and inexpensive	Minor	 <p><b>6 inches or more</b></p>

Non-Manufactured hole  (Such as crash induced hole, lug-nut damage or holes rusted-through the rail)	More than 2 holes with a height less than 1 inch on a 12.5-ft length of rail  Any holes with a height greater than 1 in.  Any hole which intersects either the top or bottom edge of the rail	Severe	
	1-2 holes with a height less than 1 in. on a 12.5-ft length of rail	Moderate	
Damage at a rail splice	More than 1 splice bolt: <ul style="list-style-type: none"> <li>• Missing</li> <li>• Damaged</li> <li>• Visibly missing any underlying rail</li> <li>• Torn through rail</li> </ul>	Severe	
	1 splice bolt: <ul style="list-style-type: none"> <li>• Missing</li> <li>• Damaged</li> <li>• Visibly missing any underlying rail</li> <li>• Torn through rail</li> </ul>	Moderate	
Vertical Tear	Any length vertical (transverse) tear	Severe	
Horizontal Tear	Horizontal (longitudinal) tears greater than 12 in. long or greater than 0.5 in. wide  <b>Note:</b> for horizontal tears less than 12 in. in length or less than 0.5 in. in height, use the non-manufactured holes guidelines.	Moderate	

**Table B-2 Generic End Treatment Damage Condition Rating Criteria (Detailed)**

Damage Mode	Extent of Damage (One or more of the following thresholds)	Damage Condition Rating (No better than)	Measurement
Damaged End Post	Not functional (sheared, rotted, cracked across the grain)	Severe	
Anchor Cable	Missing	Severe	
Anchor Cable	More than 1 in. of movement when pulled up by hand	Severe	
Cable Anchor Bracket	Loose or not firmly seated in rail	Moderate	

Stub Height	Height which exceeds 4 in.	Moderate	 <p>The diagram shows a cross-section of a building's exterior wall and roofline. A wooden structure, possibly a roof edge or a wall section, is shown. A vertical dimension line is drawn from the ground level (indicated by a dashed line and the label '(Ground level)') to the top of the wooden structure. This dimension is labeled 'Stub Height'.</p>
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